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POPULATION ANALYSIS.—*The extinction of families*—II.[1]

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Let C_N be the probability, at the moment of his birth, that a random male shall eventually have just N sons. Then, as has been shown by H. W. Watson,[2] and independently by J. F. Steffensen,[3] the probability that the progeny of this male, in direct line of male descent, shall comprise just k males in the s-th generation is given by the coefficient of x^k in the s-th iteration[4] $f_s(x)$ of $f(x)$, where

$$f(x) = C_0 + C_1 x + C_2 x^2 + \ldots \qquad (1)$$

To carry out the successive iterations of the function $f(x)$, as required according to this formula, for any considerable number of generations, would be an excessively laborious task in the general case in which the coefficients C_N may have any arbitrary values. Actually, the work is greatly simplified by the fact that the numerical coefficients $C_1, C_2, \ldots$ as computed from actual statistics (United States, white males 1920), are found to approximate the simple law of geometric progression. This is shown in Fig. 1, in which the numerical values of the C_N are plotted on a logarithmic scale against the values of N on an arithmetic scale. It will be seen that for $N = 1, 2, 3, \ldots$, the points thus plotted fall approximately on a straight line. It is true that for the higher members of the set, notably C_9

[1] Received September 23, 1931. For Part I see this JOURNAL 21: 377-380 1931.

[2] Published in *Natural Inheritance* by Francis Galton, 1889, p. 242.

[3] Matematisk Tidskrift 1930, p. 19.

[4] The notation $f_s(x)$ and its designation as the s-th iteration of f(x) is to be understood as follows:

$$f_1(x) = f(x)$$
$$f_2(x) = f\{f_1(x)\}$$
$$f_s(x) = f\{f_{s-1}(x)\}$$

In counting generations, the original ancestor must be reckoned as the zero generation, his sons as the first, and so on.

and C_{10}, there is a systematic departure from linearity. But these higher coefficients are relatively unimportant, since families comprising a large number of sons are rare. Accordingly a straight line was fitted by the method of least squares to the logarithms of the values of C_1, C_2, . . . determined by the process described in Part I (this JOURNAL, October 4, 1931, p. 377) with the results shown in Fig. 1

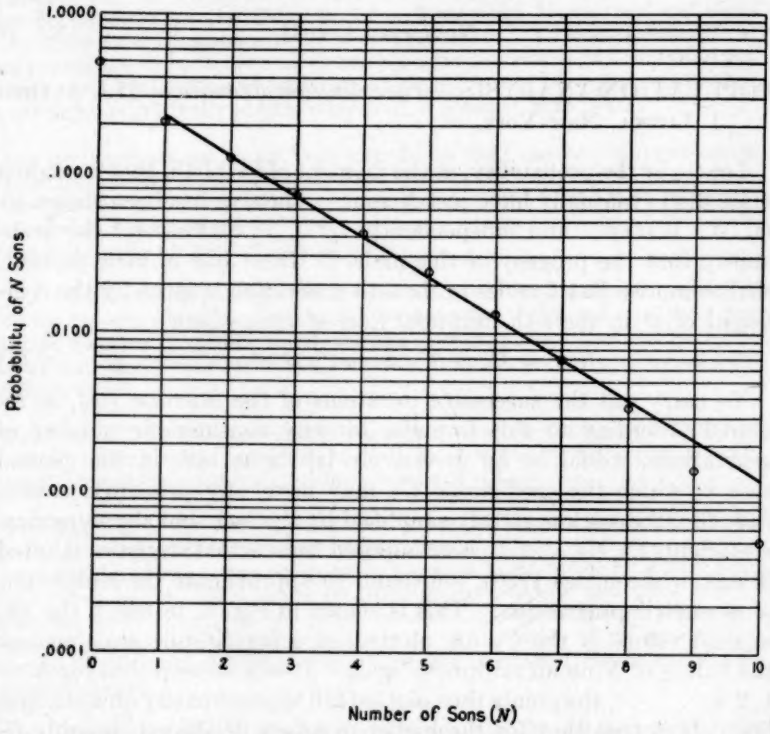

Figure 1. Probability P $(1, N)$ that a new-born male shall have N male descendents (sons) in the first generation. Based on statistics for white males, U. S., 1920.

and Table 1 in which the "smoothed" values for C_1, C_2 . . . C_{10} are those given by the least square fit

$$C_N = .4099 \times (.5586)^N \qquad (2)$$

It should be noted that C_0 is not included among the series of coefficients defined by (2). If it had been included, the set of coefficients

would in general fail to satisfy the condition $\sum_{1}^{10} C_N = 1$. Accordingly C_0 was determined separately, by the relation

$$C_0 = 1 - \sum_{1}^{10} C_N = .4828 \qquad (3)^5$$

after the "smoothed" values of C_1, C_2 . . . C_{10} had been determined as indicated above.

TABLE 1. VALUES OF COEFFICIENTS C_N

N	Crude	Smoothed[a]
0	.4981	.4828
1	.2103	.2289
2	.1270	.1279
3	.0730	.0714
4	.0418	.0399
5	.0241	.0233
6	.0132	.0125
7	.0069	.0070
8	.0035	.0039
9	.0015	.0022
10	.0005	.0012

[a] Least squares straight line fit to logarithms of $C_1, C_2, \ldots C_{10}$,
$C_N = .4099 \times (.5586)^N$

The function $f(x)$, using the smoothed values of the coefficients C_N, is of the form of a constant term plus a geometric series. It can, accordingly be written in finite form

$$f(x) = .07294 + \frac{.40986\,[1 - (.55860x)^{11}]}{(1 - .55860x)} \qquad (4)$$

In actually carrying out this iteration, the labor can be greatly reduced, with but little loss in accuracy,[6] if the geometric series is summed to infinity, instead of stopping at the term in C_{10}. The equation (4) then reduces to

$$f(x) = \frac{.4828 - .04074x}{1 - .55860x} \qquad (5)$$

[5] In equation (3) it does not very greatly influence the result whether we carry the summation to C_{10} or to C_∞, the former alternative giving $C_0 = .4828$, the latter $C_0 = .4813$, while the unsmoothed data give $C_0 = .4981$.

[6] The retention of the higher terms implies that we are including a contingent of very large families. But the coefficients C_N become so small, i.e., the theoretically very large families are so rare, that the error introduced is small.

With the function $f(x)$ thus expressed in finite form, the determination of successive iterations is now a matter of simple arithmetic, the results being obtained primarily in finite form, and being then expanded in series in order to determine the required coefficient of x^k.

The results thus obtained are shown in Table 2 and in Fig. 2. This latter has been drawn as a three-dimensional model and shows on a vertical logarithmic scale the probability $P(s,N)$ that the s-th generation shall comprise just N sons, the corresponding values of s and N being read on arithmetic scales running respectively from left to right and from the back face forward out of the plane of the paper. The values of this probability for $N = 0$ and for successive generations fall on a separate curve shown near the top on the rear face of the dia-

TABLE 2. THE PROBABILITY $P(s.N)$ PER 1,000 THAT A NEWBORN MALE SHALL HAVE N MALE DESCENDANTS IN THE s-TH GENERATION

$\frac{N}{s}$	None	One or More	1	2	3	4	5	6	7	8	9	10
1	482.80	517.20	228.95	127.89	71.44	39.91	22.29	12.45	6.95	3.88	2.17	1.21
2	634.16	365.84	98.29	72.12	52.92	38.83	28.49	20.90	15.33	11.25	8.25	6.05
3	707.65	292.35	53.97	44.19	36.18	29.62	24.25	19.85	16.25	13.30	10.89	8.92
4	750.74	249.26	33.80	29.36	25.50	22.15	19.24	16.71	14.51	12.60	10.94	9.50
5	778.83	221.17	22.95	20.68	18.63	16.79	15.13	13.63	12.28	11.07	9.97	8.98
6	798.45	201.55	16.48	15.22	14.06	12.99	12.00	11.09	10.24	9.46	8.74	8.07
7	812.80	187.20	12.29	11.56	10.87	10.22	9.61	9.04	8.50	7.99	7.51	7.06
8	823.68	176.32	9.46	9.01	8.59	8.19	7.80	7.43	7.08	6.75	6.43	6.13
9	832.13	167.87	7.41	7.13	6.86	6.60	6.35	6.11	5.88	5.66	5.45	5.25
10	838.81	161.19	5.90	5.73	5.56	5.40	5.24	5.08	4.93	4.78	4.64	4.50

gram. The values of the probability $P(s,N)$ for all other values of s and N fall on a family of straight lines which themselves fall on a ruled surface, the outstanding feature of the diagram.

Graphic iteration of the function $f(x)$. It is worth noting that the operation of constructing successive iterations of $f(x)$ is very easily carried out graphically, as follows:

In the diagram, Fig. 3, the lowermost curve represents the function $y = f(x)$ to be iterated. Draw the line OP at 45 degrees to the coordinate axes. Take any point Q on the given curve. From Q draw a perpendicular QR, and a horizontal QS meeting OP in S. From S draw a perpendicular ST meeting the curve in T. From T draw a horizontal TU meeting QR in U. Then U is a point on the (second) iteration $f\{f(x)\} = f_2(x)$. Point by point the graph of $f_2(x)$ can thus

be constructed, and from it, by a repetition of the process, the graph of $f_3(x)$ and so on. Or, in view of the relation

$$f_2\ \{f_2(x)\} = f_4(x) \tag{6}$$

the fourth iteration can be obtained directly from the second, the eighth from the fourth and so on.

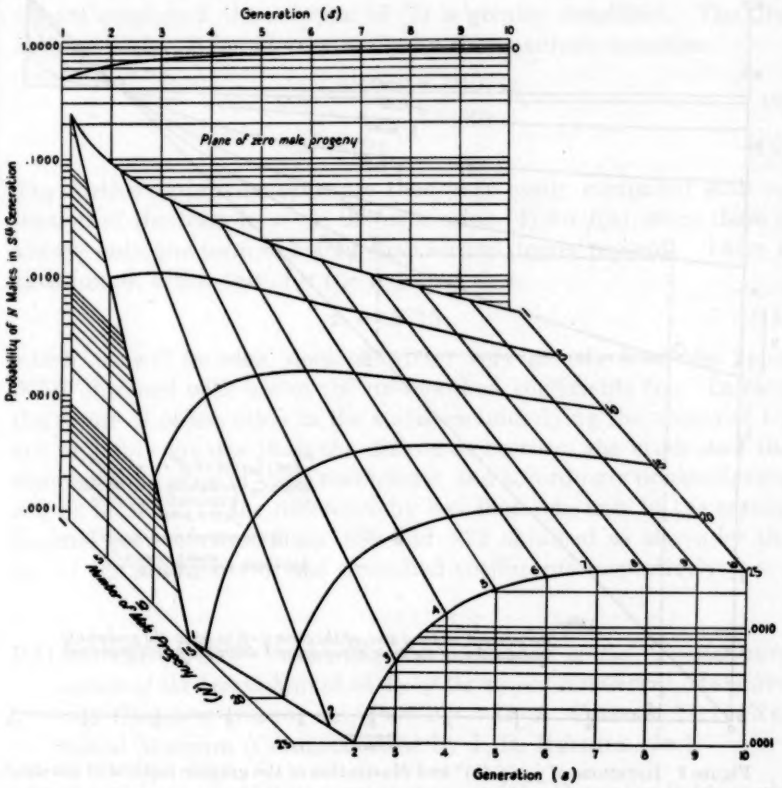

Figure 2. Probability $P\ (s, N)$ that a new-born male shall have N male descendents in the s-th generation. Based on statistics for white males, U. S., 1920.

The process is very simple and easily carried out. It must be remembered, however, that we require not merely the graphs of these iterated functions, but the coefficients of the terms in their expansion in power series. Unfortunately, for the determination of these coefficients with any satisfactory degree of accuracy the graphs are not adequate. They do, however, bring out clearly certain points of in-

terest. So, for example, it will be seen that the graphs for all the iterated functions pass through the points corresponding to the roots of the equation

$$x = f(x) \tag{7}$$

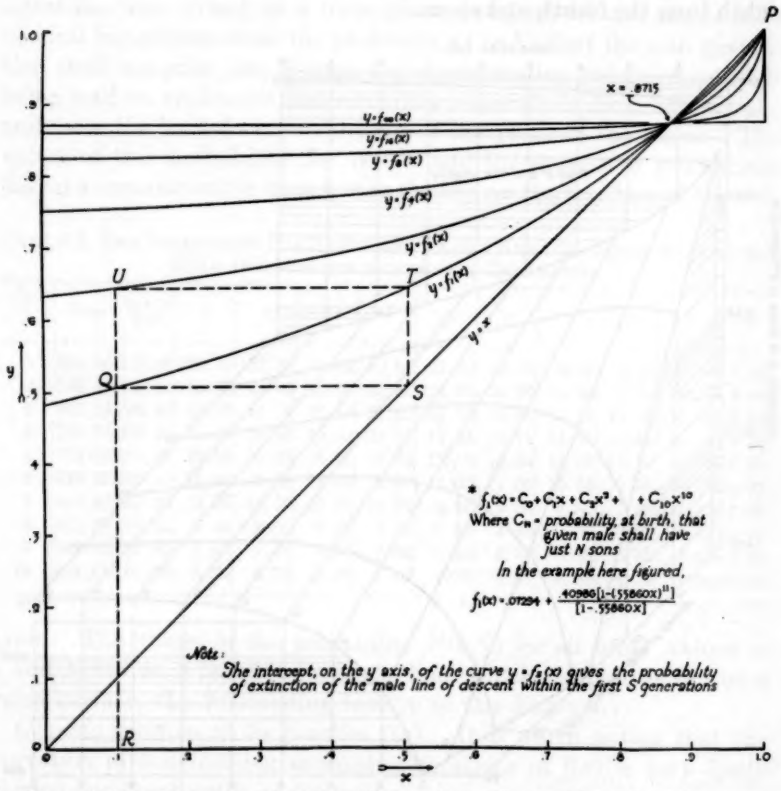
P
x = .8715
y = f∞(x)
y = f₁₀(x)
y = f₆(x)
y = f₄(x)
y = f₃(x)
y = f₂(x)
y = x
U
T
Q
S
R
y
x
* f₁(x) = C₀ + C₁x + C₂x² + ... + C₁₀x¹⁰
Where Cₙ = probability, at birth, that given male shall have just N sons
In the example here figured,
f₁(x) = .07294 + .40980[1-(.55860x)¹¹] / [1-.55860x]
Note:
The intercept, on the y axis, of the curve y = f₈(x) gives the probability of extinction of the male line of descent within the first 8 generations

Figure 3. Iterations of $y = f_1(x)^*$ and illustration of the graphic method of construction.

these roots being common also to the equation

$$x = f_s\{f(x)\} \tag{8}$$

for all values of s.

Another point of interest to note is that the successive iterated curves ultimately approach a curve consisting of two straight lines forming a right angle.

Roots of equation (7). In Part 1 of this article the root, inferior to unity, of (7) was found to be .8797 on the basis of the original unsmooth values of the coefficients C_N. This required solving by the method of successive approximations an equation of tenth degree, with terms of all degrees from the first to the tenth actually present.

It is to be noted that when the smoothed values of the coefficients C_N are employed, the solution of (7) is greatly simplified. The first approximation is found very easily by the quadratic equation

$$x = \frac{.48280 - .04074x}{1 - .55860x} \tag{9}$$

$$= .8724 \tag{10}$$

The further approximations are then very easily computed with retention of the term in x^{11} in the expression (4) for $f(x)$, since there is always only one term of higher than second degree present. There is thus found, ultimately, for the required root,

$$x = .8715 \tag{11}$$

which, as will be seen, does not differ very greatly from the value .8797 obtained with use of the unsmoothed coefficients C_N. In fact, the errors of observation in the statistics underlying the values of C_N are probably greater than the difference between the crude and the unsmoothed values of these coefficients, and accordingly no significance can be attached to the difference by less than one unit in the second decimal between the values .880 and .872 obtained as above by the use of the crude and of the smoothed coefficients respectively.

PALEONTOLOGY.—*Concerning the authorship of the "Preliminary notice of the lamellibranch shells of the upper Helderberg, Hamilton and Chemung groups, etc., Part 2"*[1] G. A. COOPER, U. S. National Museum (Communicated by J. B. REESIDE, JR.).

During the course of bibliographic studies of the Devonian Pelecypoda in connection with a projected bibliography of the Devonian invertebrates under the direction of Dr. E. M. Kindle of the Canadian Geological Survey the writer has had to refer to a paper reminiscent of the turbulent days at Albany in the Hall régime when the great *Pale-*

[1] Published by permission of the Secretary of the Smithsonian Institution. Received September 24, 1931.

ontology of New York was being conceived. The following remarks relate to the *Preliminary notice of the lamellibranchiate shells of the upper Helderberg, Hamilton and Chemung groups, with others from the Waverly sandstones, Part 2*, published anonymously in 1869 and 1870. Although many writers have accredited the publication to James Hall, evidence points strongly towards a joint authorship with R. P. Whitfield. This claim of Whitfield to joint authorship with Hall has apparently been recognized by a few writers only. In the interest of bibliographic stability it is the writer's purpose to settle permanently the question of authorship of the *preliminary notice, No. 2*, dates of genera and species described therein, and the status of the two generic names, *Modioconcha* and *Nyassa*.

The publication under discussion appeared in two forms, the first an 80-page edition distributed in December 1869 and the other an enlarged edition of 97 pages, published one month later, January 1870. Hall[2] explains the circumstances surrounding the distribution and composition of the pamphlets:

> In 1869 the writer printed and published "Preliminary Notice No. 2, of the Fossil Lamellibranchiate Shells of the Upper Helderberg, Hamilton, Portage and Chemung groups," etc., to the number of eighty pages, issued in December of that year. One hundred copies in this form were distributed. In January following the printing was resumed, and sixteen additional pages were printed. The pamphlet thus augmented, with a supplementary page stating the fact that the descriptions of other species were in type, was distributed to the public.

Hall states further that the paper was to have appeared in the 23rd Annual Report of the New York State Cabinet of Natural History "with a preparatory [sic] note making due acknowledgements for sources of aid and information . . . ." The *Preliminary notice, No. 2* did not appear in the 23rd Annual Report and by way of explanation Hall adds, "this report (23) [rd Annual Report] was, however, not published till 1872. In the meantime the burning of the State printing establishment destroyed the material in the hands of the printer (leaving some proof-sheets only in the hands of the author)." In the same preface he gives the reason for the appearance of *preliminary notice, No. 2* in advance of No. 1 as follows: "... because the investigations upon the genera there included in No. 2 were farther advanced; while comparatively little had been done in arranging the

[2] JAMES HALL. *Preliminary notice of the lamellibranchiate shells, etc.*, Part 1. Ann. Rept. N. Y. St. Mus. **35**: 215, 216. 1884.

groups preceding those described." Referring to the *preliminary notice, No. 2* Hall makes the statement that he "was very efficiently aided by Mr. R. P. Whitfield, then an assistant in the Museum, to whom he expresses his obligations."

After the distribution of the 80-page edition, the pamphlet was noticed in the American Journal of Science for March, 1870[3] in which the authorship was accredited to James Hall. The publication of the paper was also recorded in the Proceedings of the American Association for Advancement of Science[4] and likewise attributed to Hall. The Neues Jahrbuch[5] in noticing the second edition, accredited the paper to James Hall.

The basis of Hall's title to sole authorship of the paper appears to rest on the presence of a printed slip inside the cover of the 97-page edition[6] which bears the words "With Compliments of James Hall;" the presence of the name Hall inserted after two of the generic names[7] used in the pamphlet for the first time; the use of the first person singular in some of the descriptions;[8] his many references in later literature[9] to the genera proposed in the *preliminary notice, No. 2* as his own; and the fact that some bibliographers[10] have accredited this anonymous paper to Hall on the above superficial evidence.

In the course of his bibliographic studies the writer came upon the late Dr. C. D. Walcott's copy of the 97-page edition which bears valuable notes dealing with the authorship of the pamphlet. Finding Walcott's notes of such great importance the idea suggested itself that additional copies owned by other paleontologists might likewise yield valuable information. Accordingly requests were sent to several

[3] Page 276.

[4] Proc. Amer. Asso. Adv. Sci. **18:** 282. 1869.

[5] Neues Jahrb. für Min., Geol. & Pal. 1871, p. 988.

[6] Recently the writer purchased an unused copy of the 97-page edition from the University of Chicago which shows clearly the method used by Hall in distributing this edition of the paper in question. Inside the cover is pasted a slip bearing the following printed words: "With compliments of James Hall, N. Y. State Museum Natural History, Albany, N. Y., U. S. A." This was a common method of distribution of New York State Museum publications.

The writer does not know if such a slip appeared with the 80-page edition since the copies seen were without covers. James D. Dana's copy bore "With the respects of James Hall" in Hall's writing. These "compliments" and "respects" of James Hall do not necessarily imply authorship by Hall, as was evidently assumed by the American Journal of Science for March, 1870.

[7] *Nyassa*, p. 28; *Pholadella*, p. 63.

[8] See under *Modioconcha*, p. 27; also pages 34, 44, and 62.

[9] *Pal. N. Y.* V, Lam. I & II, 1884 & 1885, resp.

[10] S. A. MILLER. *North American Geology and Paleontology*, II, 1889; SCUDDER. *Nomenclator zoologicus*, U. S. Nat. Muss. Bull. **19**. 1882.

universities and museums. Dr. Charles Schuchert of Yale University loaned his personal copy of the 97-page edition and James Dwight Dana's copy of the 80-page edition, both of which carried valuable notes. Through Dr. R. Ruedemann the New York State Museum loaned Dr. John M. Clarke's copy of the 97-page edition. The writer extends his thanks to Drs. Schuchert and Ruedemann and the New York State Museum for their kindness.

Whitfield's first printed claims known to the writer appear in the *Geology of Wisconsin, Part III, Paleontology*, 1882, pp. 335–337, and the *Annals of the New York Academy of Science*, volume II, no. 8, 1882, pp. 201, 216, 233, and 244. In these reports Whitfield cites the *Preliminary notice, No. 2* giving Hall and Whitfield as authors and states that the pamphlet was "distributed without author's name." In his faunal lists Whitfield cites a species[11] described in the *Preliminary notice, No. 2* as "H. & W."

Whitfield's claim was brought to public attention prior to the publication of the *Geology of Wisconsin, Part III, Paleontology* by C. A. White[12] who cites the pamphlet as "Anon [Hall and Whitfield]" and in addition makes the following remarks:

> This memoir was noticed in the *Am. Journ. Sci.*, vol. xlix, 2d series, p. 276, and attributed to James Hall, although the work itself bears the name of no author. It does not appear that Prof. Hall has anywhere claimed sole authorship; but, on the contrary, Prof. Whitfield has claimed the authorship to be jointly with Prof. Hall and himself. See *Ann. Rep. Wisconsin Geol. Surv.* 1878, p. 51, and *Paleontology of Wisconsin* (now in press), pp. 136, 137, and 138.— . . . .

White's reference to Whitfield's claim in the *Annual Report of the Wisconsin Geological Survey* for 1878 and the *Paleontology of Wisconsin* have been checked by the writer. The first reference is evidently an error by White since Whitfield's claim does not occur in this report, nor in the reports for 1877 and 1879. In the *Geology of Wisconsin, Part III, Paleontology*, Whitfield's indications of joint authorship with Hall appear on pages 335–337, not the pages cited by White. It is possible that Whitfield informed White of his intention to publish his claims to joint authorship with Hall, or White may have seen the manuscript or proof-sheets of the *Annual Report* for 1878 above cited but the claim never appeared because of deletion or some other reason. Whitfield continued these claims in later publications[13] and

[11] *Geol. Wis.* **1**: 369. 1883.

[12] Bull. U. S. Geol. & Geog. Surv. Terr. **5** (1): 144. 1879.

[13] Ann. N. Y. Acad. Sci. **5**: 523, 545, 559, 561, 604, 614. 1891; **12** (8): 140, 185, 186; *Geol. Ohio* **7**: 422, 437, 438, 440, 451, 453, 494. 1893.

the fact that they were ignored by so many writers is doubtless because the case was never thoroughly investigated.

There are certain points of evidence in the paper which strongly substantiate Whitfield's claim to joint authorship with Hall. There is an occasional use of the word "we," and the appearance of Whitfield's initials[14] on pages 84, 91, and 93. These Hall evidently failed to delete during the apparently hurried proof-reading of that part of the paper. To this oversight may be added another of Hall's which appears in the legend to plate 14, figure 7, of the *23rd Annual Report of the New York State Cabinet of Natural History.* In this legend the species, *Microdon tenuistriatus*, described as a new species in the *Preliminary notice, No. 2*, page 32, is cited under the authorship of "H. & W.", the initials clearly indicating Hall and Whitfield. In support of Whitfield's claim also is the oral statement of Dr. Edwin Kirk of the United States Geological Survey who says that, in conversations with Whitfield, the former associate of Hall declared that he (Whitfield) wrote the *Preliminary notice, No. 2* and was to have received joint authorship with Hall.

Still more conclusive than the evidence cited above is that contained in a note written by Dr. C. D. Walcott on the first page of his copy of the sconnd edition. This copy, presented to Walcott by Hall, bears the notation "With compliments of James Hall" in Hall's hand writing. Walcott, evidently aware of Whitfield's claim, asked Hall to write his name as author if he claimed *sole* authorship to the pamphlet, but Hall refused to sign his name (see fig. 1). Hall's refusal to assume sole authorship of the *Preliminary notice, No. 2* places him in the peculiar position of substantiating Whitfield's claim. James Dwight Dana's copy of the 80-page edition also bears evidence, for, in his own handwriting, Dana attributes the authorship to Hall and Whitfield.

The fact that Hall and Whitfield's names are associated together in other papers prepared at this time shows that an agreement of joint authorship with Whitfield was not entirely distasteful to Hall. Three of these papers[15] actually appear in the *23rd Annual Report of the State*

[14] Whitfield calls attention to the appearance of his initials in the *Preliminary notice, No. 2* in the Ann. N. Y. Acad. Sci. **12** (8): 140. 1899.

[15] *Descriptions of new species of fossils from the Devonian rocks of Iowa*, pp. 223–239; *Notice of three new species of fossil shells from the Devonian of Ohio*, pp. 240, 241; *Notice of two new species of fossil shells from the Potsdam sandstone of New York*, pp. 241, 242. The last two papers are without an author's name but are included under article (F) along with the first. The legends to plates 9–12 accompanying these articles attribute all of the species to Hall and Whitfield.

C. D. Walcott Esq
with the compliments
of James Hall
Received June 22d 1881.
C. D. W.

PRELIMINARY NOTICE

OF THE LAMELLIBRANCHIATE SHELLS OF THE UPPER HELDERBERG, HAMILTON AND CHEMUNG GROUPS, WITH OTHERS FROM THE WAVERLY SANDSTONES.

[Preparatory for the Palæontology of New-York.]

PART 2.

GENUS MODIOLA (LAMARCK).

MODIOLA PRÆCEDENS (n. s.).

SHELL elongate-ovate, very oblique, a little more than twice as long as wide. Valves moderately ventricose: beaks small, appressed; cardinal line short, less than half the length of the shell, slightly alate and compressed at the extremity; postero-basal border broadly rounded; anterior end short, narrow and laterally compressed; byssal side slightly sinuate.

SURFACE marked by fine concentric lines, and by fine radiating wrinkled striæ which diverge along the median line and curve toward the opposite margins of the shell.

Formation and locality. In a band of conglomerate and sandstone of the Chemung group, south of Olean, Alleghany county, N.Y.

MODIOLA METELLA (n. s.).

SHELL elongate-ovate, greatest breadth nearer the anterior end; posterior and antero-basal margins subparallel: beaks small, laterally compressed. Valves evenly ventricose: cardinal line a little more than one-third the length of the shell, slightly arcuate; anterior end projecting but little beyond the beaks, inflated and rounded at the margin; postero-basal extremity sharply rounded.

SURFACE smooth, or indistinctly marked by concentric lines or undulations of growth.

This species differs from the last in the absence of radiating striæ, and very materially in the form of the shell, which attains a larger size, so far as observed. The general features of this shell are similar to those of *Mytilus* (*Mytilarca*) *occidentalis* (WHITE & WHITFIELD) from the sandstones of Burlington (Iowa); but it is more regularly ventricose, and not so frequently marked by concentric undulations, while the hinge line is more oblique to the axis of the shell. These features will serve to

Request of Prof. Hall to write his name as author of this pamphlet if he claims it.
sole authorship. Yr. influenced to do so. Chas. D. Walcott. June 22d 1881.

Author's claim of Prof. R. P. Whitfield as Hall-Whitfield &c

Figure 1. Photographic copy of page 1 of Dr. C. D. Walcott's copy of the *Preliminary notice, No. 2.*

Cabinet of Natural History, the publication that was to have contained the *Preliminary notice, No. 2*.

The question of bibliographic stability rather than of justice to Whitfield has impelled the writer to revive this claim of Whitfield's to joint authorship in the *Preliminary notice, No. 2*. Although some writers have credited Hall with sole authorship, White, Dana, Walcott, and Etheridge[16] considered it a joint publication of Hall and Whitfield. The pamphlet as distributed from the New York State Museum was an anonymous paper and as such has no standing; its contents could be ignored and all of the genera and species contained therein dated from 1883 when the *Palaeontology of New York*, vol. V, part 1, *Lamellibranchiata*, Plates and Legends appeared. This however, would lead to a great deal of confusion. It would seem preferable to affix to the anonymous paper the same of the senior author, who was directing the researches embraced by the pamphlet, and the name of the junior author who obviously had a large share in its preparation. It is recommended therefore, as a move towards stability, that subsequent bibliographers recognize the authors of the *Preliminary notice, No. 2* as Hall and Whitfield. This procedure will be followed in the forthcoming bibliography of Devonian invertebrates.

The establishment of authorship is not the sole problem connected with the *Preliminary notice, No. 2*; there are, among other points, the questions of dates for genera and species and the status of certain genera and species. The question of dates arises from the fact that there were two editions of the pamphlet, the second edition containing 17 pages more than the first. The genera and species in the first, or 80-page edition, take the date December 1869, and those described on pages 81–96 of the second or 97-page edition date from January 1870. On page 97 several new species of *Schizodus* and *Lunulacardium*, a new genus *Mytilops*, and a new subgenus of *Pinna*, *Palaeopinna*, are mentioned but are unaccompanied by descriptions; these are therefore *nomina nuda* and have no standing. The species and genera[17] mentioned on this page are properly indicated in *Palaeontology of New York*, volume V, Part 1, *Lamellibranchiata* (*plates and legends*), 1883 and must

[16] R. JUN. ETHERIDGE. Rec. Austral. Mus. **11** (10): 223. 1917. Cites *Modiomorpha* correctly as Hall and Whitfield, 1869.

[17] *Cardiola ventricosa*, nom. nud., in the *Preliminary notice, No. 2* is not mentioned in Pal. N. Y. **5**, pt. 1, Lam. (Plates and legends) 1883, but appears in Pal. N. Y. **5**, pt. 1, Lam. 2, 1885, p. 417, pl. 69, figs. 1, 2. In Pal. N. Y. **5**, pt. 1, Lam. (Plates and legends), 1883, pl. 69, figs. 1, 2, the very same figures bear the name *Cardiola? elevata*. Evidently the latter name has priority.

date from the publication of that volume. The species *Schizodus quadrangularis* (n. s.), page 96, also must stand as a *nomen nudum* because its description is incomplete. This species is adequately indicated in the "*Plates and legends*" 1883.

It will be of interest to mention several miscellaneous points, as follows: a). Although the name *Cimitaria* is used in the *Preliminary notice, No. 2* for the first time, it is not designated as a new genus, probably due to oversight. b). Whitfield's claim that Hall's name was inserted after *Pholadella*[18] without his knowledge can not be recognized. "*Pholadella* (Hall n. g.)" must stand as written, for, once it is agreed that the paper is a joint product of Hall and Whitfield, it must be accepted as published. *Pholadella* is to be cited, therefore, as "*Pholadella* Hall 1869, in Hall and Whitfield 1869." c). Under the heading "Genus *Schizodus* King," the synonyms of the genus are given, and are followed by the name "*Curtonotus*" in small capitals. It is not clear if *Curtonotus*, a *Schizodus*-like genus created by Salter, is to be regarded as a subgenus of *Schizodus* because it appears in no other place and furthermore all the species are listed as *Schizodus*. d). The familiar names *Palaeoneilo* and *Palaeanatina* are spelled in this paper "*Palaeaneilo*" and "*Palanatina*," probably an example of inadequate proofreading, of which there are many more obvious ones throughout the pamphlet. The current spelling is correct and will be continued.

The case of *Modioconcha* versus *Nyassa* is interesting because the two genera rest on the same genotype. *Modioconcha* has never been favored by use but *Nyassa* on the other hand, has been in general use since it was first proposed. On page 27 of the *Preliminary notice, No. 2* remarks on several genera are concluded with a paragraph in which the subgeneric name *Modioconcha* is proposed for a pelecypod thought by the "authors" to have a close relationship to *Modiolopsis*. The type of the proposed subgenus is given as *Nyassa arguta*. Following the characterization of the new subgenus *Modioconcha*, is the heading "Genus *Modiolopsis*" with the subheading "Subgenus *Nyassa* (Hall)." These headings are followed by descriptions of four species of *Nyassa*, the first species being *N. arguta*. Although this is the first use of the word *Nyassa*, except for its mention as the genotype of *Modioconcha* referred to above, there is no description of the subgenus *Nyassa* and no type is designated. However it is clear that the two genera are synonyms, *Modioconcha* having *N. arguta* as type, and *Nyassa* having *N. arguta* as its first species.

[18] Ann. N. Y. Acad. Sci. **2** (8): 233. 1882; **5**: 609. 1891; Geol. Ohio **7**: 494. 1893.

Later, in 1882, Whitfield published the first characterization of the genus (subgenus) *Nyassa* and stated that the generic description had been omitted from the *Preliminary notice, No. 2*.[19] Whitfield selected *N. arguta* as the genotype. Since *Modioconcha* and *Nyassa* are to be regarded as having been proposed simultaneously the life of either depends on the first reviser who has the privilege of selecting one of these two genera.[20] Whitfield, as first reviser, selected *Nyassa* and named *N. arguta* as the type of the genus, and ignored the obscure *Modioconcha*. Further the writer holds that it is desirable to retain *Nyassa* as a genus in preference to *Modioconcha* because the latter has been totally ignored. Scudder[21] does not list *Modioconcha*, and Hall in the final copies of the *Paleontology of New York*, volume V, *Lamellibranchiata*, recognizes the name *Nyassa* only. The single mention of *Modioconcha* known to the writer in the literature subsequent to 1870 is by Beushausen[22] who lists the name in his synonymy of *Nyassa* but fails to use it. On this basis then *Modioconcha* Hall and Whitfield becomes a synonym of *Nyassa* Hall and Whitfield 1869. In the *Preliminary notice, No. 2* the name "(Hall)" is inserted after *Nyassa* on page 28 but is not followed by the usual "n. g.". For this reason it is suggested that Whitfield's name accompany Hall's as author of the genus.

[19] Ann. N. Y. Acad. Sci. **2** (8): 216, 244; **5**: 558, 1891; *Geol. Ohio* **7**: 451.

[20] See Article 28, *International rules of zoological nomenclature*, Proc. Biol. Soc. Washington **39**: 82.

[21] Scudder. *Nomanclator zoologicus*. U. S. Nat. Mus. Bull. **19**: 1882.

[22] Abhandl. königl. preuss. geol. Landesanst., n. f., Heft 17, p. 29, 1895.

ZOOLOGY.—*On the status of the nemic genera* Aphelenchus *Bastain*, Pathoaphelenchus *Cobb*, Paraphelenchus *Micoletzky*, Parasitaphelenchus *Fuchs*, Isonchus *Cobb and* Seinura *Fuchs*.[1] G. STEINER, Bureau of Plant Industry.

About a year ago, while examining diseased gladiolus corms from New Egypt, New Jersey, and again in looking over some diseased Irish potatoes from South Africa, nemas were found closely resembling that described by Cobb in 1913 as *Isonchus radicicolus*. In the gladiolus corms a single such male was seen, together with numerous females, while many males were found in the potatoes. These males were specifically identical with the associated females,—which were, beyond doubt, *Aphelenchus avenae*. A detailed study supports this view in every way. The male of *Aphelenchus avenae* is thus identified as Isonchus of Cobb. In 1927 Goodey called attention to the close resemblance of the head end of *Isonchus radicicolus* to that of the female *Aphelenchus avenae*. The proposal by Cobb of a new genus mainly on the basis of the male characters is good evidence that the male of *A. avenae* is utterly different from the males hitherto assigned to Aphelenchus. This difference is so great that the two types cannot reasonably be placed in a single genus. Seemingly, it would be most logical to retain Isonchus as the generic name for what has been called *Aphelenchus avenae*. Unfortunately the rules of nomenclature prevent this. According to Stiles and Hassal (1905), Bastian through correspondence made *avenae* the type of *Aphelenchus*. Nevertheless the portion of the genus which is thought of by every nematologist when the generic name is used is that which includes *A. parietinus*, *A. fragariae*, *A. olesistus*, *A. ritzema-bosi*, etc., all quite different from *avenae*. The usual generic diagnosis was chiefly shaped after these species, since males were known for these species only. The absence of a bursa in the male, a character which is general in all these forms, was always considered one of the main generic features, especially in contrast with Tylenchus. Even Bastian himself does this by default. However, the generic name Aphelenchus Bastian, according to the rules of nomenclature, must be connected permanently with *A. avenae*, because this form was selected by Bastian as the type of the genus. This makes the reclassification of the former genus more complex. It was an unfortunate choice to designate this species, of which the male was unknown at the time, as the type, when another

[1] Received September 30, 1931.

species like *A. parietinus*, with both sexes known, could have been designated. This is even more deplorable because, as before mentioned, one of the main generic characters—the absence of a bursa—was based on the male of *A. parietinus*.

It is evident that the whole classification of what has been called Aphelenchus must be revised, even though the genus has included a number of economically important parasitic species recorded in an extensive literature, so that the renaming must create confusion.

Under the rules of zoological nomenclature, *Aphelenchus avenae* Bastian remains as the type species of the genus Aphelenchus. Aphelenchus must be synonymized with the genus Isonchus Cobb.

Thus the forms placed in the genera Aphelenchus, Isonchus and Paraphelenchus now fall as follows:

1. *Aphelenchus*, with four or, more probably, two species, namely: *A. avenae*, *A. agricola* de Man (if it is different from *avenae*), *A. radicicolus-Isonchus radicicolus* (if it is different from *avenae*) and *A. Cylindricaudatus* Cobb (Steiner 1926).

Diagnosis: Aphelenchus, nemas resembling Tylenchus but differing in the following characters; spear without basal swellings (knots); posterior portion of oesophagus not distinctly set off from the intestine, which apparently begins just behind the middle bulb; the latter well developed, oval, with valvulae; dorsal salivary gland emptying in front of, subventral behind, these valvulae. Female with a more or less reduced posterior branch of the uterus; male with a gubernaculum and a well developed bursa with several bursal ribs.
Type: *A. avenae* Bastian 1865.

2. *Pathoaphelenchus* (Cobb), (Syn. Parasitaphelenchus Fuchs) proposed in 1928 as a subgenus of the formerAphelenchus, to include forms like *A. parietinus* etc., which do not have a bluntly rounded, but conical or even filiform tail end. It is proposed to give Pathoaphelenchus generic standing and to include in it the forms Cobb placed in his subgenus.

Diagnosis: Pathoaphelenchus, nemas similar to Aphelenchus but the males without bursa and without a gubernaculum. Spear mostly with basal swellings (knots) or furcated at its proximal end. Type: *P. parietinus* Bastian. The subgeneric division proposed by Cobb would be retained:

subgen. Pathoaphelenchus with the spear with basal swellings (knots), not furcated posteriorly. Type: *P. parietinus* (Bastian) 1865.

subgen. Schistonchus with the spear furcated posteriorly. Type: *S. caprifici* (Gasparrini) Cobb 1928.

subgen. Seinura (Fuchs) emend with the spear as in subgenus Pathoaphelenchus but without basal swellings or knots. Type: *S. mali* Fuchs.

This last subgenus was proposed as a new genus by Gilbert Fuchs in 1931, and characterized as resembling Aphelenchus but having a spear without basal swellings or knots and an elongated tail. Considering that an earlier described Pathoaphelenchus (*P. demani*) has also an elongated tail, the only remaining differentiating character would be the absence of swellings or knots on the spear. This, however, we cannot consider as of generic importance, and propose Seinura as of subgeneric standing.

Recently Fuchs created the genus Parasitaphelenchus to include a large number of new species. Unfortunately he gives no diagnosis. The genus as he describes it cannot be distinguished from Pathoaphelenchus. It is therefore thought best to consider it synonymous with the latter. Possibly later some of the forms he referred to it may be placed to advantage in one or several new genera, their generic diagnosis being formulated anew. But some at least of the new species of Fuchs would have to remain with Pathoaphelenchus, its generic diagnosis applying fully to them. This matter is more fully discussed in a recent paper (Steiner, in press).

3. *Paraphelenchus* Micoletzky. This is a good genus. Its standing and the forms belonging to it are discussed in another paper (Steiner and Cassidy, in press).

Diagnosis: Paraphelenchus, nemas resembling Aphelenchus but with a posterior (post-bulbar) oesophageal portion, which is distinctly set off from the intestine; males with a gubernaculum but without a bursa, their tail being short, more or less obtuse and having a number of irregularly arranged papillae.

Type: *P. pseudoparietinus* Micoletzky 1922.

APHELENCHUS AVENAE Bastian

Syn.: *Aphelenchus agricola* de Man, 1885

This species has been discussed by a number of authors. Goodey (1927, 1928 and 1929) added perhaps most to our knowledge, and first called attention to its close resemblance to *Isonchus radicicolus*, which may prove to be synonymous. As far as can be seen at present, they differ in no way. The male of *A. cylindricaudatus* (syn. *Tylenchus cylindricaudatus*) can hardly also be distinguished from it; here, however, the female exhibits some differentiating characters.

It has long been an open question as to the synonymy of *A. avenae* and *A. agricola*. The only marked difference between the two species is the striation of the lateral fields described for *A. agricola* but not mentioned by Bastian for *A. avenae*. However, Bastian may well

have overlooked them. In fixed material it is often difficult, even impossible, to observe them, although they are rather plain in all living specimens. This is true too for the caudal papillae as described by de Man for the female tail of *A. agricola*. Sometimes they are very faint or are not seen at all.

A. avenae seems to be a very polyphagous species since it has been discovered on a great variety of plants. From January to July 1931 it was seen by the writer as follows:

In	Irish potatoes	from South Africa (2)
"	"	" England (4)
"	"	" Canada (7)
"	"	" Argentina
"	"	" Denmark
"	"	" Finland
"	"	" Egypt
"	sweet "	" New Jersey
"	carrot	" Brazil
"	"	" South Africa
"	"	" Germany
"	onion	" Greece
"	"	" Egypt
"	"	" Italy
"	"	" Germany
"	narcissus	" Virginia (2)
"	"	" New Jersey (2)
"	"	" New York
"	"	" Mississippi
"	"	" Illinois
"	"	" Holland (2)
"	iris	" Holland (2)
"	anemone	" New York (2)
"	cactus	" Germany
"	Caryopteris sp.	" France
"	strawberry	" Massachusetts
"	"	" Oregon
"	peony	" Ohio
"	cotton seedlings	" South Carolina

Not only is the variety of plants with which it is found associated apparently large, but its geographical distribution also seems to be worldwide. Little is known as to its closer relationship to the various plants. It is perhaps one of the species with facultative parasitism, that is, it can live as a true parasite but does not necessarily have to do so, being able also to support itself in a saprophytic mode. Its parasitism may be ecto- or endo-parasitism. In gladiolus the nemas were found in brownish spots all through the corms and were located

by cutting the latter into pieces. There is a certain phaenotypical difference in the specimens from the various hosts, those from potato tubers, carrots and similar rich food being relatively larger and fatter.

Few facts are to be added to the morphology of the female. The number of the striae on the lateral fields, if counted in the middle region, is most often 12. The number, however, diminishes toward both ends of the body. These striae are crenate according to the cuticular annulation. The latter, however, stops at these lateral fields. In the male these structures are the same. A careful comparison of the sexes reveals this to be true for all morphological characters common to both. Figure 1, A represents the anterior end of a male. If compared with Figure 3 and the description given by Goodey (1929) and others, complete similarity is seen. Special stress is laid upon the fact that the oesophageal glands have not only the same arrangement but also the same order of outlets in the oesophageal bulb.

Most striking is the male copulatory apparatus. It somewhat links conditions as seen in Rhabditis with those of Tylenchus. The spicula resemble somewhat those of Rhabditis in that they have ventrally a semicircular protuberance. The proximal end is slightly capitate. In a side view (fig. 1,G) the gubernaculum appears to be almost lineate and of about half the length of the spiculum. Seen ventrally (fig. 1,F) however it appears to be a broad but flat piece. Most interesting is the bursa, the presence of which so widely separates this form from all those of the genus Aphelenchus as hitherto conceived. From the Tylenchus bursa it differs by the multiple bursal ribs, which, if this is, as it seems, a generic character, brings the genus Aphelenchus near to Rhabditis. One rib is located slightly in front of the anus, the three others on the second half of the tail, being separated from each other by about equal distances. The bursa encloses the tail end. The presence of some bursal muscles anterior to the bursa itself is probable. A retractor spiculi was seen in the usual position. The testis is reflexed (fig.1,D). In the material from South Africa which contained a larger number of male specimens, a female with a definite copulatory mark on its vulva was seen (fig. 1,C). Such marks are not infrequently seen in the bisexual Rhabditis species. In the present case it shows that copulation may take place. It is, however, assumed by most writers that *Aphelenchus avenae* is a syngonic species. What significance then has the sporadic appearance of males? They seem to be fully functional, at least to judge from the above mentioned copulation mark. There are no explanations available based on experimental

or other evidence. However, reference may be made to similar conditions in some of the Rhabditis species. Under certain circumstances, probably of external character, males appear in some of these normally

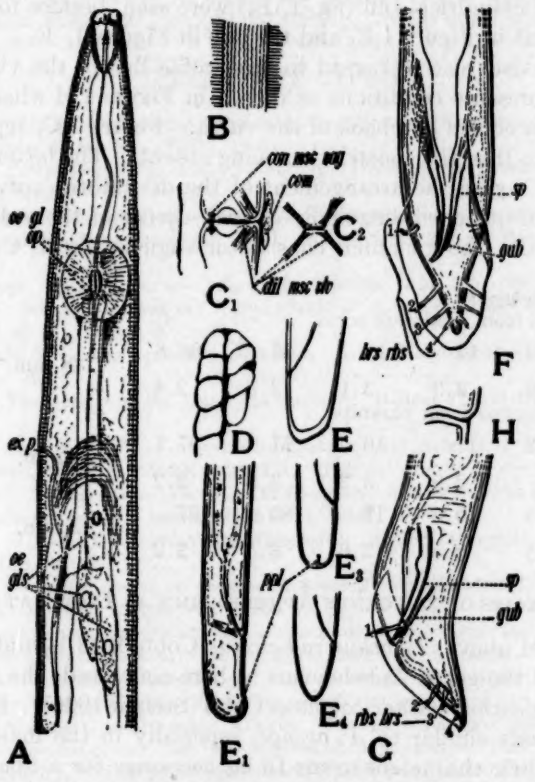

Fig. 1.—*Aphelenchus avenae* Bastian. A. Head end of male. *ex p*, excretory pore; *oe gls*, oesophageal glands; *oe gl op*, openings of oesophageal glands; about × 533. B. Structure of lateral field. C_1. Side view of vulva and vagina; *cem*, cement left from copulation, *con msc vag*, circular constrictor vaginae; *dil msc vlv*, dilatator muscle of vulva. C_2. Front view of vulva with obliquely placed dilatator muscles. D. End portion of testis reflexed. $E,E_{1,3,4}$. Various types of tail ends. F. Ventral view of male tail end; *gub*, gubernaculum; *sp*, spiculum; *rbs brs 1–4*, bursal ribs; about × 533. G. Side view of male tail end; legend same as in Fig. F; about × 533. H. Side view of vulva to show the sudden contraction behind the vulva.

syngonic species, exceptionally even in considerable number. The mechanism of their appearance, however, is unknown. The resem-

blance of *A. avenae* to Rhabditis along this more physiological line is rather significant.

Finally attention should be called to the fact that in the present species the tail of the female exhibits a certain variation; forms with the typical cylindrical tail (fig. 1, E_3) were seen, besides forms with a tail like that in Figure 1,E_1 and the one in Figure 1, $E_{3,4}$. A certain variation exists also in regard to the profile line of the vulva, which usually represents conditions as drawn in Figure 1,H where a sudden constriction occurs just back of the vulva. Figure 1,C_1 represents an exception to this, the constriction being absent. The latter figure and Figure 1, C_2 give the arrangement of the dilatatores vulvae, four in number and attached diagonally at each corner of the vulva. There seems to exist also a circular constrictor vaginae (fig. 1, C_1).

Measurements:

Male from gladiolus corm

1.9	12.	14 .	M.	96.8	.748 mm.
1.9	2.9	3.1	3.5	2.4	

Specimens from parsnips

2.2	11.	16.	M.	97.1	.74 mm.
2.	2.9	3.2	3.8	2.2	
1.5	10.6	12.	80.	97.	.82 mm.
1.5	2.5	2.6	3.5	2.2	

THE SPECIES OF THE GENUS APHELENCHUS AS KNOWN AT PRESENT

As stated above, *Isonchus radicicolus* Cobb 1913 is undoubtedly a member of the genus Aphelenchus as here conceived; the same is the case for *Tylenchus cylindricaudatus* Cobb (Steiner 1926). Both species are extremely similar to *A. avenae*, especially in the male and a revision of their characters seems to be necessary for a final ascertainment of their taxonomic position. On the basis of data available at present, the following diagnoses may be given:

A. avenae Bastian, type species (Syn. *A. agricola*)

Diagnosis: Aphelenchus with the characters of the genus; lateral fields in the middle region of the body with about twelve longitudinal striae, crenate according to the annulation. Four bursal ribs; female tail cylindroid or obtuse conical.

A. cylindricaudatus (Cobb) (Steiner 1926)

Diagnosis: Similar to *A. avenae* but lateral wings well developed, crenation irregular, not conforming with the cuticular annulation. (Lateral fields without longitudinal striae?). Female tail somewhat finger-shaped, its base

conical, next portion cylindrical, end portion somewhat swollen and bluntly rounded.

⊥*A. radicicolus* (Cobb 1913)

Diagnosis: Characters of *A. avenae* but a single lateral wing (apparently without lateral fields and longitudinal striae!). Male bursa with 5 ribs.

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SCIENTIFIC NOTES AND NEWS

F. M. SOULE of the Department of Terrestrial Magnetism, who was one of the scientific staff on board the *Nautilus*, arrived in Washington, D. C., October 14, bringing with him the magnetic and depth data obtained. Despite the necessary curtailment in the cruise because of lateness of the season valuable data were secured in physical and chemical oceanography, terrestrial magnetism, gravity, and marine biology.

ANDREW THOMSON, formerly director of the Apia Samoa Observatory, who recently returned from eight months' meteorological studies in Europe is temporarily engaged at the Department of Terrestrial Magnetism in the

reduction and discussion of the 171 pilot-balloon series over the Pacific Ocean obtained on the *Carnegie*.

DR. L. E. LOVERIDGE of the University of California reported September 28 at the Department of Terrestrial Magnetism to assist in the high-voltage laboratory.

The United States Geographic Board on October 7, 1931, adopted a resolution naming a crater in Coconino County, Ariz., "Merrill Crater," in honor of the late Dr. GEORGE P. MERRILL, who was the first scientist to investigate and describe Meteor Mountain, which is in the vicinity of the newly named Merrill Crater.

The staff of the Division of Mollusks of the National Museum has been increased by the appointment of Mr. HORACE G. RICHARDS of the University of Pennsylvania, to the position of Aid.

Obituary

JAMES WILLIAMS GIDLEY, Assistant Curator of Mammalian Fossils in the U. S. National Museum and a member of the ACADEMY, died September 25, 1931, at Washington after a protracted illness. Dr. Gidley was born in Winneshiek County, Iowa, on January 7, 1866. He obtained his professional training at Princeton University, where he took a master's degree, and at George Washington University, where he received the doctorate. He was attached for some years to the American Museum of Natural History, transferring in 1905 to the National Museum and remaining with that institution until his death. Dr. Gidley chose the study of the fossil mammals as his special field and attained distinction in it. His earlier work concerned the Eocene mamals, but in later years he dealt chiefly with the later faunas. His most recent work was with the late extinct fauna of Florida, which is associated with human remains, and with an older fauna of the late Pliocene of Idaho.